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ABSTRACT

GRADES OR AGES; Kindergarten. SUBJECT MATTER: Mathematics. ORGANIZATION AND PHYSICAL APPEARANCE: The guide has seven sections: 1) emphasis in mathematics; 2) three approaches--use of number in daily activities and content areas, manipulative materials and mathematically structured materials, and structuring special activities and/or problems; 3) number and operations, the natural numbers--counting and numeration; 4) elements of a set; 5) measurement and estimation--meaning of measurement; 6) geometry; and 7) bibliography of books for K-3. The guide is lithographed and spiral bound with a soft cover. OBJECTIVES AND ACTIVITIES: General objectives are discussed in the first section. Sections 2-6 contain detailed descriptions of activities. INSTRUCTIONAL MATERIALS: Materials needed are described in the various activities, and there is also a 69-item bibliography. STUDENT ASSESSMENT: None. (MBM)

BLOOMINGTON PUBLIC SCHOOLS
INDEPENDENT SCHOOL DISTRICT NO. 271
BLOOMINGTON, MINNESOTA

Mathematics in the Kindergarten

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I. EMPHASIS IN MATHEMATICS

The emphasis in mathematics today is on <u>understanding</u> our number system. Because it is possible to compute with numerals and not understand number concepts, relationships, and/or processes we must teach for and evaluate understanding.

- Can the child manipulate concrete things to prove a point, to show why?
- Can he express understandings in <u>language</u> rather than symbolic markings?
- Can he count with one-to-one correspondence rather than rote counting?
- Can he build patterns with things?
- Can he show number structure by using "things" to show structure?
- Can he theorize or hypothesize (a step in problem solving) as to how to solve a problem?
- Is he flexible in his approach to solving problems (there are many ways of arriving at the same conclusion)?

Because the teacher is aware that all learning is developmental (based on the child's own pacing and past experiences) and because concept development is dependent on many multi-sensory experiences, the teacher must plan varied sensory experiences suitable to mathematical goals as well as <u>timely</u> and <u>appropriate</u> to the interests and abilities of individual children. Because learning moves from the concrete to the symbolic, the environment will be full of manipulative "things".

In kindergarten, even though numerals are in the environment, (calendar, toy clock, walk-on-number line, thermometer, numerals on the floor tile, etc.) the emphasis will be on what the numeral stands for. The numeral 3 is only important because it means either three things or the third one or three o'clock!

II. THREE APPROACHES

Mathematical understanding will be developed by taking advantage of the use of number in daily activities and within content areas; by providing mathematically structured materials; and by creating special activities and/or problems in order to achieve an objective.

1. TAKING ADVANTAGE OF THE USE OF NUMBER IN DAILY ACTIVITIES AND CONTENT AREAS THAT ARE A PART OF DAY BY DAY LIVING IN THE KINDERGARTEN. FOR EXAMPLE:

- Daily Activities . . .
  - roll call - number absent, present, etc.
  - calendar - numeral for today, number of days until _____,
  - thermometer - numerals near the top mean warm, comparing days
  - news time - number telling or sharing news
  - songs - Ten Little Indians, Three Little Witches, etc.
  - fingerplays - cardinal and ordinal meaning; example, Five, Little Squirrels - First one said
  - rhythms - "Heel Toe - (clap) One, Two, Three", etc.
  - work period - designated number in set of children to doll house, work bench, etc.
  - evaluation time - used five colors, made three wheels on airplance, he used less than you did
  - clean up time - first finished, last done, put on middle shelf
  - game time - create games to achieve specific objective
  - story time - see attached bibliography
  - dismissal time - "special set" may get coats first today
- Content Areas
  - Science
    - leaves or flower petals that grow in sets of 2, 3, 4, 5, 6

sunflower leaves - in sets of 2
sumac leaf - 6 leaves on each side of stem

- compare needles from pine trees - how many needles in each cluster; does the same tree always have the same number

  white pine - 5 needles in each cluster
  norway pine - 2 needles in each cluster

- compare legs on living things

  6 on spider
  4 on grasshopper

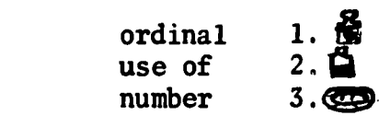
- use scale - weigh items in room; more, less, heavy, light

- count clips that this magnet will pick up - count clips that the other magnet will pick up

- measure growth of children and plants,etc.

- picture chart of steps in an experiment

ordinal use of number



1. "First we filled two jars with "clean" snow.
2. The snow melted into water.
3. We poured the snow water over cotton.

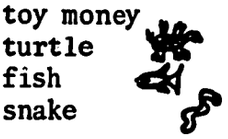
- Social Studies

- make a picture book of circus acts with pages numbered. On page 1 is a picture of the circus band. Why is there a numeral 1 when we know all the children were in the band? Page 8 shows two children with hoola hoops and two children with jumping ropes. Why? Yes, it was the eighth act in our circus. There were seven acts before the hoopers and our jumpers.

ordinal use of number

- use toy money in grocery store, pet shop, hat shop

  match price on sign to the toy money



turtle	10¢
fish	5¢
snake	1¢

- Language Arts

- Finish these sentences:

  A boy has as many legs as _____.
  A dog has as many legs as _____.
  You have as many eyes as there are wheels on a _____.

You have as many fingers on one hand as there are toes on one_____.
I have as many ears as I have _____.
Two children standing together have as many legs as _____.
I have one nose on my face and one _____.

Ocasionally insert a "joker" for the fun of it.

Which has more legs, a mother elephant or a baby elephant?
Which has the smaller number of ears, a cocker spaniel or a mouse?

Which do you have more of, fingers or toes?

2. PROVIDING A VARIETY OF MANIPULATIVE MATERIALS, AND/OR MATHEMATICALLY STRUCTURED MATERIALS, MANY OF WHICH ARE SELF-ADJUSTING TO A CHILD'S LEVEL OF UNDERSTANDING AND INTERESTS AND WHICH PROVIDE AN OPPORTUNITY FOR THE CHILD TO MAKE DISCOVERIES AND TO LEARN INDUCTIVELY. FOR EXAMPLE:

- Cuisenaire Rods
- Counting Stairway
- Walk on Number Line
- Number Dominoes
- Numberite
- Peg Numerals
- Fit - A - Space
- Design Cubes
- Fruit Plate (fractions)
- beads
- blocks
- peg boards
- magnetic counting discs and numerals
- flannel board and felt items and numerals
- sand paper numerals and tag board counters

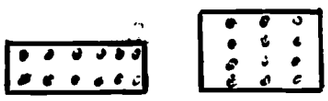
3. STRUCTURING SPECIAL ACTIVITIES AND/OR PROBLEMS IN ORDER TO ACHIEVE AN OBJECTIVE. FOR EXAMPLE:

•the distributive property of number

give block builders 9" x 12" tagboard with a line down the middle and a numeral on top. These are to be used as

parking lots holding a designated set of cars. Children with a numeral 4 on their parking lot may discover many ways to park their cars: 2 on one side and 2 on the other or 3 and 1 or 1 and 3 or 4 and 0 or 0 and 4.

•which egg carton holds more eggs?



use two different kinds of egg cartons which make two different arrays.

children make guesses and then are encouraged to place the eggs (plastic Easter eggs) in cartons during work period to find out which carton holds more. They will discover that they hold the same number! Will they be curious about the arrangement of eggs?

• play Roll the Ball and Tell All

stand 5 blocks on end in center of circle 

a child rolls the ball and knocks some down 

encourage the child to "tell all" that he sees -

there are some blocks up and some blocks down

there are three blocks up and two blocks down

there are more blocks up and less blocks down (prove it by one-to-one correspondence)

In using these three approaches the teacher must know the mathematical objectives to fully achieve the potential learnings which are inherent in the materials and program of the kindergarten.

The objectives which follow were taken from the Bloomington Public School Guide, Mathematics Program, pages 19, 20, 21, 22.

III. NUMBER AND OPERATIONS
THE NATURAL NUMBERS-COUNTING AND NUMERATION

If your goal is to . . .

DEVELOP NUMBER CONCEPT, COUNTING THE NUMBER IN A SET (OF FROM ONE TO NINE OBJECTS) - and RELATING THE NUMERAL REPRESENTING THE COUNT . . .

The importance of any numeral is the number it represents. To help a child to discover the "fiveness of five" the "threeness of three",etc., try using the "Mystery Number Box' and live with a number (and it's relation to the numeral) for a week at a time.

PLANNED EXPERIENCE

Use a mystery number box (cigar box covered with "Sets" of dots). Choose a child to come and unlock the padlock and see what our surprise number for this week will be?!

What number will be the "mystery" number this week? I wonder what John will find in the box? What is it John? How many blue discs (raised cardboard circular shapes on the numeral 3) are there? If you didn't know, how could you find out? Yes, by counting! Pin it up, John, on that big empty bulletin board.

Now let's start living with the number three right now! Look around the room; when you see a group, a set, an arrangement of three things, tell us about it! (Prior to this time the teacher has arranged table decorations for each of the work tables appropriate to the time of the year; for example, three Christmas trees, three pine cones, three angels, three bells, three ornaments. She has three colors of paper cut for the paper chains to be made today.) The children not only notice these things, but make many discoveries over a week's time that are a point of the discussion each day.

The following comments are typical responses of kindergarten children who will be having a multitude of experiences with the concept development of the number three:

DISCUSSION TIME

- "there are three pieces of furniture in the doll house that hold dishes; the sink, the bottom of stove and the hutch"
- "there are three puzzles with pieces missing"
- "there were three beds, chairs, bowls, and spoons for the three bears"
- "there are three big bulletin boards"
- "there is a numeral 3 on the clock and on the calendar"
- "there are three rows of lights on our ceiling"
- "there are three big 'teacher' chairs"
- "there are three sides to a triangle"
- "there are three reporters" (a science reporter, a weather reporter and a coat room reporter)
- "there is a numeral 3 with three holes in our Peg Numbers"
- "there were three boots not in the lockers but only two people had to go to put them away!"
- "there is a 'three units' rod on our Counting Stairway"
- "there are 'three bumps' on our Numberite"

GROUP SHARING AND EVALUATION OF WORK ACTIVITIES

- "there were three painters today at the easel"
- "one painter used three colors; the others used all five of the colors. How many more colors did the other two painters use? (Use one to one correspondence)"
- "there were four members in the family in the doll house but one member left the family to join the block builders"
- "there were only two block builders to start with but one more joined the group"
- "there are three letters in Bob, Bill, Sue and Tom's names"
- "Larry has worked three days on the work bench"

"who hung up the magazine pictures with three things in each picture?"

"Mary, Betsy and Bill made patterns with the beads to hang up on our 'number bulletin board'"

Betsy-three green, three yellow, three blue, three green, three yellow, three blue (She used three colors and three beads of each color.)
Mary -three cubes, three cylinders, three round, three cubes, three cylinders, three round (She used three shapes and three beads of each shape.)
Bill -three yellow round, three blue cubes, three green cylinders, three yellow round, three blue cubes, three green cylinders (He controlled three variables: number, shape and color.)

ROLL CALL When I say your name today come up to the flannel board and make a set of three things (have triangles, circles and squares in three colors and three sizes). Encourage divergency and a description. Some children will discover the three variables and want to make more than one set, while ordering according to size, color, or shape.

RHYTHM TIME

1. We need three groups or sets of children to work in Santa's toy shop. Mary, you be in charge of the workers to make dolls, buggies, or anything little girls like. John, you be in charge of the workers who make trains, airplanes, cars or anything boys want for Christmas, and Sally, you be in charge of the workers who are going to paint all the toys. Now, how can we divide the group into three sets of workers so each set has about the same number? (After there is time for thinking, if there is no response, have children recall how Miss Reed divided us into four teams for the relay races, or how the children who were the "Three Pigs" chose three more to be the "Three Bears" and they choose three more to be the "Three Billy Goats Gruff").

Yes, they each choose one more to take their place.

2. Indian Drum. Beat out sets of three sounds - children respond by clapping or stamping the rhythm

(3 long even)___ ___ ___, ___ ___ ___, ___ ___ ___

(long, short, long) ___ _ ___, ___ _ ___, ___ _ ___

(short, long, long) _ ___ ___, _ ___ ___, _ ___ ___

(3 fast even) _ _ _, _ _ _, _ _ _

(long, long, short) ___ ___ _, ___ ___ _, ___ ___ _

GAME TIME - play games using different combinations of three children or three things. The algorithms will be done orally.

(1+2)=3
(2+1)=3
(1+1+1)=3

1. LOST KITTENS - two kittens and a mother cat

2. MISSING CHILD - one policeman, one mother, one missing child

3. MORE OR LESS - two children in center of circle each have three lollipops (in one-to-one correspondence in front of them) As they close their eyes, someone else can move one lollipop from one set to the other. As the two children in center open their eyes they quickly say, "I have more", or "I have less." (Let's hope some creative child adds the fun of just rearranging the order of sets and not the number so the two in center must say "we have the same."

4 > 3
3 < 4

4. WALK ON NUMBER LINE - play "Where are You?"

- take two steps and one more - "where are you?"
- take one step and one more and one more - "where are you?"
- take one step and two more - "where are you?"
- take five steps, turn around and come back two - "where are you?"
- take four steps, turn around, come back one step - "where are you?"

5. SIMON SAYS

- clap your hands three times
- clap your hands one time more than three
- jump three times

•jump one less than three times

•hold up three fingers (comment on different ways of showing it)

6. MATCH MINE - circle game - direct five children to arrange sets of blocks in front of them

•Susie - set of 1 block

•Bob - set of 2 blocks

•Dick - set of 3 blocks

•Sally - set of 4 blocks

•Roger - set of 5 blocks

•Now choose Dick to say "Match Mine." Encourage the rest of the group to think about what Susie will have to do to match Dick's. "She will have to go get two more blocks." What will Bob have to do?" "He needs one more." "Sally has to take one away." "Roger has to take two away." Some might discover that Roger could give his two extra blocks to Susie and Sally could give her extra block to Bob!

7. DIRECTIONS - follow a series of directions

1. Jump to the book shelf
2. Take three books off the shelf
3. Skip back with the books

or

1. Walk to the door
2. Knock three times
3. Tiptoe back

DISMISSAL TIME

1. You may get your coat if . . . .

•you have three buttons on the front of your dress or shirt

•there are three children in your family counting yourself

•there are three members in your family

•you have three pets at home

•you have three eyes (no one should go)

•you have three pockets

•you have less than three pockets

•you are more than three years old!

2. Sally, you may choose two sets of three children to get their coats.
John, you may choose two boys and one girl to get their coats, etc.
Martha, you may choose one more than three children to get their coats, etc.

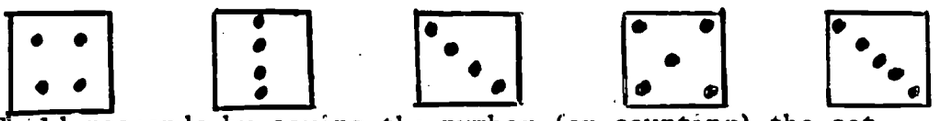
Similar activities can be used to develop the other number concepts each time a different numeral is removed from the Mystery Number Box.

Other activities to develop the number property of sets in relation to the numeral . . .

1. Print numerals on containers (include zero). Children place the corresponding set of objects from a collection into each container.

2. Prepare discs about three inches in diameter; write a numeral from 0 - 10 on each. Place the numeral discs in the same box with the beads and string. Child strings discs and beads starting with zero (no beads) and places the right number of beads on the string after each numeral disc.

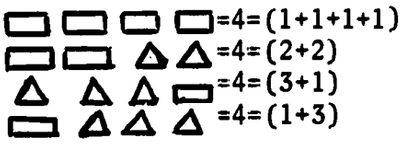
3. Prepare 6 x 9 cards to use for roll call or for dismissal. Teacher says child's name and shows him a card.



Child responds by saying the number (or counting) the set dots on the card. The teacher then places the corresponding magnetic numeral on the magnet board.

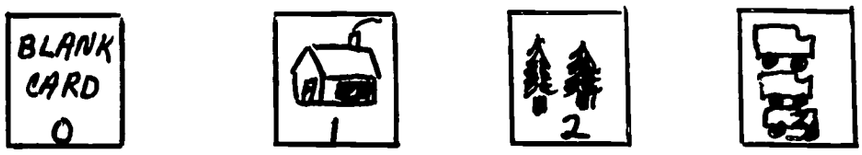
4. At a later date use the magnetic counting discs and place sets on the board; the child can come and place the magnetic numeral with the corresponding set.

   Another day the child can show the many ways to make a set of "four" or "five", etc, on the flannel board using different colors of felt pieces, or different shapes



the algorithms are done orally

5. Make cards with numerals and corresponding number of objects. Objects may be cut from interesting textured materials and pasted on cards. (tactile approach)



III. NUMBER AND OPERATIONS
THE NATURAL NUMBERS COUNTING AND NUMERATION

If your goal is the . . .

INTRODUCTION OF ONE-TO-ONE CORRESPONDENCE CONCEPT

MAKING A ONE-TO-ONE CORRESPONDENCE BETWEEN TWO SETS OF OBJECTS (WITH FROM ONE TO FIVE OBJECTS)

MAKING A ONE-TO-ONE CORRESPONDENCE BY MAKING A TALLY OF A SET OF OBJECTS

1. Do we have the same number of fingers on each hand? How do you know? Yes, by counting. Can you think of another way to show or prove that we have the same number of fingers on each hand? Each hand has a thumb, a pointer finger, a middle finger, a ring finger, a baby finger; now make the thumb touch the thumb, the pointer touch the pointer, etc. Are there any fingers left over, any fingers that don't have a partner?

   Repeat this activity with a pair of gloves. Match glove to glove, glove to hand, etc.

2. There are three girls and two boys absent today. Are there more boys absent or more girls? John, you stand up here for Dick, who is absent. Mary, you stand up here for Sally who is sick. Sue, you take Mary's place, etc. Now, how can you show or prove that there are more girls absent (or less or fewer or not as many boys who stayed home)? If no one suggests the matching of one to one, recall for the children how we matched our fingers to our fingers, the glove to the glove, the glove to the hand, etc. - lead children to match one absent boy to one absent girl (hold hands). "Are there any girls without partner?" "Yes." "What does that show us or prove to us?" "There are more girls absent or there are less boys absent than girls." "How many more or less?" "How do you know?" (3>2 algorithm is 2<3 done orally)

Repeat this activity at roll call time many times during the year using children to represent children. Gradually introduce other "things" to represent the absent children (moving from concrete to less concrete) such as flannel board cut-outs of girls and boys, or blocks, or beads, or felt squares and triangles and then chalk stick figures on blackboard to finally using tally marks on board.

3. When dividing the group for rhythms are there more children in group 1 or group 2? How can we find out? Can you prove it? How?
4. Are there more winners or losers? How do you know? How many more?
5. Are there more black shoes or brown shoes? Show me how you found out.
6. Are there more characters or less characters in the stories, The Three Bears, The Three Billy Goats Gruff, The Three Little Pigs - don't forget Goldilocks, the troll or the wolf. Can you prove it?

   After children line up 3 children as bears + 1 as Goldilocks
   3 children as pigs + 1 as wolf
   3 children as goats + 1 as troll

   they should be perplexed as they cannot answer the question - which set has more or less characters as they all have the same number of characters!
7. Place beads according to the same color or shape sequence as shown on a pattern.
8. Pass out sets of scissors, papers, notices,etc.,to a designated set of children.
9. Match mittens to hands; cups to saucers; block to block,etc.
10. Place animals in zoo cages (one-to-one).
11. Match on flannel board equivalent sets and nonequivalent sets (3 squares to 3 triangles and 3 squares to 4 triangles)

12. Match number of paint brushes to number of paint containers.

13. Cut shapes to fit into the squares of the calendar. These may be seasonal (leaves, snowflakes, kites, etc.). Each day a child may place one of these shapes on the calendar in the square for that day.

14. Play "Squirrel in a Tree" or "Astronauts and Planets" or "Musical Chairs", etc.

    Have 4 planets and 5 astronauts. The extra astronaut says "Blast Off." Children exchange places and one is left over.

15. We need as many members in the family as there are chairs in the doll house! How many do we need?

16. We need as many finger painters as I have paper laid out! How many will paint today?

17. We need as many block builders as there are wheels on one truck. How many will build?

18. We need as many Lotto players as there are Lotto cards plus one more for the caller! How many can play at one time?

19. Take a trip on the Walk-on-Numberline

    - stand on home base (the zero) and take a trip to four (child counts as he walks)
    - walk as many steps as you are old
    - walk as many steps as you have fingers on one hand
    - walk as many steps as there are wheels on a bicycle, tricycle, days in a week, days in a school week, days until your birthday, days until the paper sale, days until vacation, pennies in a nickel, pennies in a dime
    - take one step more than 6
    - take one step less than 5
    - walk as many steps as there are people or members in your family, brothers in your family, sisters, children in your family

20. Play More or Less

Two children in center of circle with their eyes closed, each with a matching set of objects in one-to-one correspondence between them. Someone comes in and moves one object to the other set. Then the group chants "feathers, feathers on the floor who has less and who has more." The two children open their eyes and the one who says, "More" or "Less" first is the winner.

Feathers could be changed to a different set of items to be appropriate with unit of study, such as

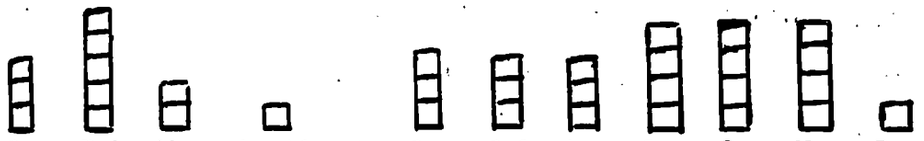
- 2 sets of pheasant feathers for hunters
- 2 sets of Indian feathers as chiefs
- 2 sets of fruits and vegetables for farmers
- 2 sets of toys for Santa's helpers
- 2 sets of mittens for winter players
- 2 sets of valentines
- 2 sets of kites, Easter eggs,etc.

21. Make a "birthday" block graph for one-to-one correspondence, many-to-one-correspondence, none-to-one correspondence.

- when discussing the calendar (perhaps in January when children are conscious of a new year, new calendar - count the number of months in the new calendar. Place 12 items or pictures from calendar on floor to represent the 12 months
  - a cotton snowman for January
  - a valentine for February
  - a kite for March
  - a Easter bunny for April
  - a flower for May
  - a jump rope for June
  - a fire cracker for July
  - a picnic basket for August

- a school building for September
- a jack-o-lantern for October
- a turkey for November
- a Christmas tree for December

Now each child who has a birthday in January may place a block behind the snowman picture. If there are 3 birthdays in January the block tower would be 3 blocks high, etc.



From this graph the children can answer these questions:

- which month has the most birthdays in it?
- which month has the least? (empty set)
- which months have the same number of birthdays?
- which month or months has 1 more birthday than in May? (Dec. and April)
- which month has 1 more birthday than in April and Dec.? (March)
- etc.
- etc.
- see movie F3019, The Calendar: Our Record of Time

III. NUMBER AND OPERATIONS
THE NATURAL NUMBERS COUNTING AND NUMERATION

If your goal is . . .

DEVELOPING AN UNDERSTANDING FOR WORDS AND PHRASES DENOTING RELATIONSHIPS - SAME AS, IS DIFFERENT FROM, IS SMALLER THAN, IS LARGER THAN, IS MORE THAN, IS LESS THAN

This goal is best achieved when the teacher takes advantage of the many opportunities for children to make comparisons and distinctions in terms of number, size, shape, length, height, width, and weight.

'see book attached bibliography

'see movie F8013 - How Little, How Big

IV. ELEMENTS OF A SET

If your goal is . . .

DEVELOPING A CONCEPT OF A SET, MEMBER OR MEMBERS OF A SET, NAMING AND RENAMING SETS, ORDERING SETS

Children are usually familiar with terms such as bunch, (of flowers, of bananas) group, (of kids, chairs) family, (the people at my house) flock, (birds, sheep) sets (of dishes, of blocks). Explain that when we talk about the number of things in a collection of things we call this a set.

1. Proceed to make sets of children and name the sets -

- those wearing black shoes
- those wearing brown shoes
- those wearing red shoes
- those wearing grey shoes
- those wearing saddle shoes

After dividing the group into sets by shoe color, then change the sets and rename the sets

- those with shoelaces
- those with buckles
- those with no shoelaces or buckles

2. Place a set of plastic food in center of circle;

(set of parquetry blocks)

(set of geo-blocks)

(set of pencils, crayons, paint brushes, chalk)

name the set - count the members of the set, change the order of the set and recount. Then have children make new sets according to size or color or shape or use and then rename and recount the number of members of each new set. (set of food becomes a set of fruit and a set of vegetables, or a set of red food and a set of yellow food or a set of long narrow food (corn and bananas)

and a set of round red food (tomatoes, radish, apple, strawberry])

3. Put objects that children have brought to share into sets according to size, shapes, colors, textures, uses,etc.

4. Make and describe sets of flannel pieces, pegs, beads, blocks,etc.

5. At roll call time ask: Who is absent today? How many are absent all together? Bill, stand up here and pretend you are Robert (who is absent), Sue, you take Mary's place and Betty, you take Janice's place. Two girls in one set - one boy in another set - now let's put the sets together. We can't call it "the set of girls" or"the set of boys" because now they are in a new set. What can we call this new set? Yes, "a set of children who are absent." Or what else? "A set of kids who are sick" or "a set of kids who didn't come to school", "a set of boys and girls who are at home." Roger, come up and count the members of our new set. Did you notice he started counting by touching Bill's head first? Can you rearrange the children and still get three? Heidi, you come up and move the children to a different place and then count. Debbie is there another way to change the order of the children or members of the set?,etc.

6. Play "Ice Fishing Game." Children sit in a circle. Blocks of ice (15 or 20 blocks) are placed in the middle. Under some of the blocks of ice, one or more paper fish are placed. One child is the fisherman who goes walking on the ice, stepping carefully on the blocks. He looks under three of the blocks to see if there are fish. If there are some he may take them as part of his "catch". His "catch" is a set. Children may count to see how big it is.

7. Each child has "some" counting discs and a sheet of paper; have the children place the correct number of discs on their paper - to match your set of blocks or felt cutouts on the flannel board.

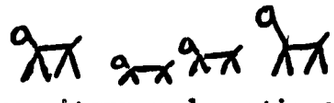
V. MEASUREMENT AND ESTIMATION
MEANING OF MEASUREMENT

If your goal is to develop . . .

CONCEPTS OF LENGTH AND HEIGHT INTRODUCED THROUGH WORDS OF COMPARISON: (longer, shorter, taller, smaller, larger)

Encourage comparing activities in non-technical language of children

- compare amount by size, and/or weight of piles as well as by number
- compare objects painted at work time; number of colors used, size of figures, etc.
- compare boots (size, length of foot size, number of buckles) to find the lost mate to a pair
- refer to objects as tall, short, fat, thin, skinny, tiny, etc., etc. - use many synonyms
- read books on measurement
  - Berkley, Ethel S. The Size of It
  - Krasilvosky, Phyllis The Very Little Girl
  - Krauss, Ruth The Growing Story
  - Shapp, Charles Let's Find Out What's Big and What's Small
    (see others on attached bibliography)
- compare big pictures of small houses and small pictures of big houses, etc.
- see movies - F1151 "Fast Is Not A Ladybug"
- take a handful of objects of different lengths (pencils, chalk, candy canes, rods from counting stairway) and hold in hand. Ask the children which item is longest, tallest, shortest, etc. Have a child come up and order items according to size. Now have children close their eyes as you pick up some pencils or rods. Have a short pencil pushed up high in hand to make it look tall and taller pencil pushed down further into your hand, etc., to look shorter. Children will open their eyes and guess which pencil is shortest, longest, or tallest. They should discover you cannot judge unless you see both ends of pencil or rod. Or they might realize even though something is "higher", it may not be the "longest".
- encourage children to estimate by letting them have a quick look at a set of objects and then quickly covering the objects. Estimate:
  - number of objects in set
  - which object is tallest
  - which object is shortest



- uncover items and continue making size distinctions
  - which item is taller than two others
  - which item is taller than three others

- which item is taller than one other
- which animal has three others that are larger
- which animal has one other that is larger
- which animal has three others that are larger

- estimate by showing with your arms, the length of paper chain you will make. Relate number of links to the number of days until _____, (my birthday, Halloween, Christmas, Valentine's Day). Each day remove one link.

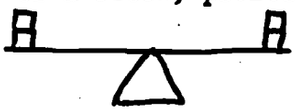
- place an outline of a flag in yarn on bulletin board. Children make red, white and blue paper chains to fill in the field of blue and the stripes. Child can come to board and measure yarn outline to see if his chain is long enough; estimate the approximate number of additional links he will need to add or to remove.

If your goal is to develop . . .

CONCEPTS OF WEIGHT INTRODUCED THROUGH WORDS OF COMPARISON (heavier, lighter)

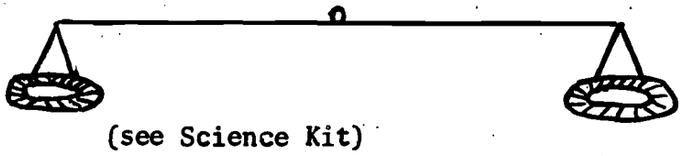
1. Bring a scale into the kindergarten and weigh children and things in the room; compare which are "heavier than", and "lighter than".

2. Balance a board on top of a block, preferably on a wedge-shaped block



3. Allow children to use and make discoveries relating to the number of items and placement of items on a balance scale.

4. Make a hole on the 18" mark of a yard stick, and then a hole on both ends of a yard stick. To each end attach an aluminum pan. Hang yard stick up by attaching string on clip to center hole.



(see Science Kit)

VI GEOMETRY

If your goal is . . .

DEVELOPING AN UNDERSTANDING FOR WORDS AND PHRASES DENOTING THE RELATIVE POSITION OF OBJECTS FRONT, REAR, BACK, MIDDLE, BY, TOWARD, SIDE, IS HIGHER THAN, IS LOWER THAN, IS INSIDE, IS OUTSIDE, IS ON, IS FIRST, IS LAST, IS BETWEEN, IS NEXT TO, IS HERE, IS THERE, IS OFF, IN FRONT OF, IN BACK OF

This goal is best achieved by a teacher who is aware of the importance of children responding to the preciseness of language. Develop meanings for words through the use of synonyms.

Play - Simon Says
- move two steps toward me
- put your hands between your knees
- put your hands by your side
- step inside the circle
- jump outside the circle

Play - Directions Game
- tap 5 children to get in a line
- skip to the rear of the line
- then jump to the front of the line
- lead 5 children and return to the group

Read pictures -
- is this the rear door of the house?
- is this the front or the back of the card?
- is this the first picture or last picture? How do you know?
- what is next to the dog?
- what is in the middle?

See Geometry movies

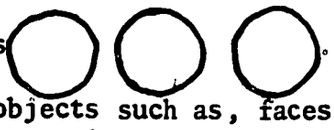
VI. GEOMETRY

If your goal is . . .

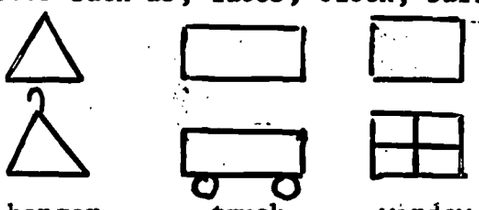
RECOGNIZING SOLID SHAPES: CUBE, BALL, OBLONG, WEDGE, DISK, CYLINDER
RECOGNIZING PLANE FIGURES: SQUARE, TRIANGLE, RECTANGLE

1. Build awareness of geometric shapes in the physical world.

Provide a box of felt shapes children can use to make designs on flannel board.

Draw shapes such as  Children take turns adding features or parts to make familiar circular or round objects such as, faces, clock, ball, lollipops, balloons, etc.

With these shapes they can make things like this:



hanger truck window

As a roll call activity, name shapes and have each member of the class name an object for that shape.

Example: circular - "button," "penny," "clock," "eyes on clown," etc.
round - "glove," "ball," "bead," "head," etc.

Look at pictures from magazines, art work, etc., to find shapes.

Look at three dimensional objects: furniture, jewelry, etc., to find geometric shapes.

Look for shapes in nature: flowers, seeds, moon, spots on animals, etc.

Play games, e.g.,: "I Spy." Give children turns to spy around the room after teacher gives the clues.
"I spy a large green rectangular shape" (door)
"I spy a rectangle you can see through." (window)
"I spy a circular shape with numerals on it." (clock)
Etc.

"Ball Game." Place large colored shapes on the floor. (These may be paper or be drawn with chalk.) Teacher gives directions, "Bounce the ball two times in the circle." Later the teacher may add another direction. "Bounce the ball two times in the square and two times in the triangle," etc.

"Mailman Game." In a paper bag have 5 envelopes. Each envelope should contain several shapes of different colors. Mailman delivers the "letters" to children in the circle. Children who receive "letters" stand up and take turns telling what each received. "I received 4 yellow circles." "I received 1 blue triangle and 3 green squares." etc.

"Dismissal Game." Each child draws from a container a colored shape. "If you have a shape like this you may get your coat." etc. (The children may make the shapes.)

'Read books: "A Kiss Is Round."
"Round As A Pancake."
see bibliography

'Give each child a bag to take home. "Bring back something round." (orange, ball, jar lid, earrings, bracelet, etc.) This activity leads to discussions which can bring out several concepts of round: disc, flat round (a coin), cylinder form (roll from waxed paper), sphere (ball), etc.

'Have a treasure hunt for shapes.

'Make pictures (cut and paste) from geometric shapes out of cloth, paper, cardboard, etc. These shapes may be precut by the teacher or the child may cut his own.

'Take a walk to find things that are geometrically shaped. (signs, parts of buildings, parts of cars and trucks, etc.)

'Build a bulletin board of shapes; have children make things of various shapes, bring things from home to match various shapes. Shapes could be made of yarn and objects could be placed within the shape to match.

'Make a booklet of shapes. Children draw their own pictures and/or cut pictures from magazines to paste in it.

'Use pounding boards. Children may place nails in shape of square. Place a rubber band around it. This may be done for the various shapes.

'Make sandpaper shapes for children to feel.

'Develop language labels for shapes used in stringing beads in a pattern. (2 spheres, 3 cubes, 4 cylinders)

'Discuss the likenesses and differences: of the cylinder in the peg board, the bead set, and the block set; of the spheres in the room, the globe, the round beads, playground balls, marbles and clay snowmen.

'Discuss the shapes in the Hammer-Nail Set, Geo Blocks, and Fit-A-Space.

BIBLIOGRAPHY OF K-3 GRADE BOOKS
with Mathematical Ideas*

Ambler, C. Gifford. Ten Little Foxhounds. Grosset, 1958, unpaged, $2.30. Grades K-1.

Ten hounds chase a fox. The hounds drop out one by one until none remain. Story and pictures illustrate well the concepts of numbers one through ten and of one less.

Baer, Howard. Now This, Now That. Holiday, 1957, unpaged, $2.25. Grades 1-3.

This story encourages children to look at things from different distances and different angles as they develop such comparative vocabulary as big, little, up, down, taller, straight, under, on, far, and near.

Behn, Harry. All Kinds of Time. Harcourt, 1950, unpaged $2.50. Grades 1-4.

A poetic and fanciful picture book about clocks, time, and the seasons.

Beim, Jerrold. The Smallest Boy in the Class. Morrow, 1949, 47 p. $2.50. Grades 1-3.

The antics of the smallest boy in the class are used to develop the idea of comparison. Terms such as big, biggest, small, smallest, tiny, tall and tallest are used.

Bendick, Jeanne. All Around You. McGraw, 1951, 48 p. $3.00. Grades K-4.

This science picture book describes in simple pictures and with the vocabulary of comparison, number, and measurement the why and how of the world about us. Among the many topics considered are shadows, clouds, fog and rain, the year, soil, seeds, and insects.

Berkley, Ethel S. Ups and Downs: A first book about space. Illustrated by Kathleen Elgin. Scott, 1951, unpaged, $1.00. Grades 1-2.

Pictures and text help develop concepts of up, down, high, low, bottom, top, under and over.

*The annotations are quotes from the pamphlet The Elementary Junior High School Mathematics Library (Hargrove, 1960, National Council of Teachers of Mathematics).

Bianco, Pamela. The Doll in the Window. Walck, 1953, 32 p. $2.50. Grades 1-2.

A little girl who saved her pennies to buy Christmas presents for her five sisters uses ideas of value and comparison in planning her purchases.

Bishop, Claire, and Wiese, Kurt. The Five Chinese Brothers. Coward, 1938, 44 p. $2.50. Grades 1-3.

The ordinal number ideas one through five are developed in this amusing book.

Blough, Glenn O. Wait for the Sunshine. Illustrated by Jeanne Bendick. McGraw, 1954, 47 p. $2.75. Grades 1-4.

This story of seasons and growing things utilizes many ideas of measurement and comparison as well as cardinal and ordinal numbers.

Brann, Esther. Five Puppies for Sale. Macmillan, 1948, 80 p. $2.50. Grades 1-3.

The concepts of one through six, addition, subtraction, and comparative size are illustrated in a story of the sale of a family of puppies.

Brown, Margaret Wise. Two Little Trains. Illustrated by Jean Charlot. Scott, 1949, 24 p. $3.00. Grades K-2.

Two trains journey across plains, rivers and mountains. The beginning language of size and position is used.

Budney, Blossom. A Kiss is Round. Illustrated by Vladimir Bobri. Lothrop, 1954, unpaged, $2.50. Grades K-1.

Familiar objects that are round are described in pictures and verse.

Cameron, Polly. The Dog Who Grew Too Much. Coward, 1958, unpaged, $2.25. Grades K-2.

Stilt, a small furry puppy, grows bigger and bigger and bigger and gets into all sorts of uncomfortable predicaments. Ideas of comparative size are well illustrated.

Chalmers, Audrey. Hundreds and Hundreds of Pancakes. Viking, 1941, 38 p. $1.75. Grades K-2.

The concept of hundreds as many is developed as a family of six deals with hundreds of pancakes. Also conveyed are ideas of size, position, comparison and measurement.

Corcos, Lucille. Joel Spends His Money. Abelard, 1954, 40 p. $2.75. Grades 2-3.

The value of money and ideas of saving and spending are illustrated as Joel learns how best to use his allowance.

D'Aulaire, Ingri, and Parin, Edgar. Don't Count Your Chicks. Doubleday, 1943 40 p. $3.00. Grades K-3.

An old lady counts eggs and money and makes use of the one-to-one correspondence idea while she dreams of more chickens, more eggs, and more money.

Elkin, Benjamin. Six Foolish Fishermen. Illustrated by Katherine Evans. Grosset, 1957, unpaged, $2.50. Grades K-3.

Cardinal and ordinal numbers from one through six are employed in telling about six brothers who went fishing. Each fisherman tries to find his sixth brother.

Friskey, Margaret. Chicken Little, Count-to-Ten. Grosset, 1946, 28 p. $2.30. Grades 1-2.

Chicken Little meets animals in groups of one through ten and identifies the number in each group.

Gag, Wanda. Millions of Cats. Coward, 1928, 30 p. $2.50. Grades K-2.

The story of an old man's quest to find a cat for his wife provides children with readiness experiences for large numbers.

Geisel, Theodor Seuss. Dr. McElligot's Pool. Random, 1947, 56 p., $2.95. Grades K-3.

Dr. Seuss tells of a little boy who imagines what he can catch as he fishes in a small pool. Ideas of number, comparison, shape, size, length, and height are used.

Geisel, Theodor Seuss. Yertle the Turtle. Random, 1958, unpaged, $2.95. Grades K-3.

Yertle uses concepts of number, comparison, and measurement as he yearns for a higher throne and a larger kingdom and attempts to get them.

Hengesbaugh, Jane. I Live in So Many Places. Illustrated by Katherine Evans. Grosset, 1956, unpaged, $2.80. Grades 1-3.

Relative position is developed by a child who tells of living in a house on a street in a county in a state of the United States on the North American continent in the Western Hemisphere on the earth, a part of the Universe.

Hoberman, Mary Ann, and Hoberman, Norman. All My Shoes Come in Twos. Little, 1957, 48 p., $2.50. Grades 1-3.

A story in rhyme tells about all kinds of shoes and uses the idea of two over and over again.

Hogan, Inez. Twin Lambs. Dutton, 1951, 44 p., $1.75. Grades K-2.

The story of twin lambs who wander away from their flock develops the ideas of same size, same shape, together, and distance.

Ipcar, Dahlov. Ten Big Farms. Knopf, 1958, unpaged, $3.00. Grades K-3.

The ordinal numbers from one to ten are developed in this interesting story of a city family that sets out to buy a farm.

Kay, Helen. One Mitten Lewis. Illustrated by Kurt Werth. Lothrop, 1955, unpaged, $2.50. Grades 1-3.

This humorous story about a little boy who is always losing one mitten frequently employs the words pair, both, one, each, first, and next.

Krasilovsky, Phyllis. The Very Little Girl. Illustrated by Ninon. Doubleday, 1953, unpaged, $1.50. Grades K-1.

Size is illustrated as a little girl who is smaller than a rose bush or a kitchen stool grows until she can reach a door handle, eat at a big table, and be a big sister.

Krauss, Ruth. The Growing Story. Illustrated by Phyllis Rowland. Harper, 1947, 32 p., $2.50. Grades K-2.

A little boy watches the flowers and animals grow all summer. When fall comes he discovers that he, too, has grown. Concepts of comparison and quantity are used.

Langstaff, John. Over in the Meadow. Illustrated by Feodor Rojankovsky. Harcourt, 1957, 32 p., $2.75. Grades K-2.

An old counting song for children is presented with an easy new melody and verse. The characters of the song are animals in natural habitat in groups of one to ten.

Lansdown, Brenda. Arithmetic for Beginners. Illustrated by Cynthia and Alvin Koehler. Grosset, 1959, 69 p., $2.00. Grades K-1.

Many illustrations of everyday things help a child recognize groups from one through ten.

Larsen, Harold D. Enrichment Program for Arithmetic. Row, 1956. A set of eight pamphlets for each grade, $1.60 per set. Grades 3-8.

The pamphlets contain a variety of stories of both historical and recreational value.

Leaf, Munro, Arithmetic Can Be Fun. Lippincott, 1949, 64 p., $2.25. Grades 1-3.

This amusing book tells why arithmetic is important, and considers fractions, counting, measurement, and the operations of addition and subtraction.

Lewellen, John. The True Book of Airports and Airplanes. Illustrated by Richard Gates. Grosset, 1956, 46 p., $2.00. Grades 1-3.

Language of number, position, comparison, and measurement appears in this simple, factual book about airports.

Malter, Morton S. Our Largest Animals. Illustrated by Dirk Gringhuis. Whitman, 1958, 31 p., $2.00. Grades 3-6.

Language of relative size, weight, and time and many number names from one to 12,000 are effectively used as the largest animals of the world are described.

Malter, Morton S. Our Tiniest Animals. Illustrated by Dirk Gringhuis. Whitman, 1955, 32 p., $2.00. Grades 3-5.

Language of number, weight, time, and relative size are effectively used as the life of small animals is described.

Marino, Dorothy. Edward and the Boxes. Lippincott, 1957, unpaged, $2.25. Grades 1-3.

Edward loves to collect boxes with which he makes houses the right size for himself and his pets. Application is made of the concept of comparison.

McCullough, John G., and Kessler, Leonard. Farther and Faster. Crowell, 1954, unpaged, $2.50. Grades 1-5.

Man's desire to travel farther and faster is shown to result in better means of transportation. Vocabulary of comparison is employed extensively.

McLeod, Emilie Warren. The Seven Remarkable Bears. Illustrated by Juliet Kepes. Houghton, 1954, 46p., $2.50. Grades K-3.

Po, the only polar bear in a city zoo, was bored and unhappy until he had a bright idea that changed his world. Ordinal and cardinal numbers through seven and concepts of position and comparison are used.

Meeks, Esther K. One is the Engine. Illustrated by Ernie King. Follet, 1947, 24 p., $2.00. Grades K-2.

The ordinal numbers one through ten occur as each car of a ten-car train is identified. Illustrations offer opportunity for counting the cars as the train grows larger.

Merwin, Decie. Time for Tammie. Walck, 1946, 40 p., $1.75. Grades K-2.

Tammie, almost six, makes a game out of telling time by pretending her arms are the hands of a clock. Young readers will want to play the clock game as Tammie does.

Norling, Joe, and Norling, Ernest. Pogo's Sea Trip: A Story of Boats. Holt, 1949, 50 p., $1.75. Grades 1-3.

A tugboat trip by John and his dog Pogo reveals a good deal about boats, locks, lighthouses and navigation, and makes wide use of number and comparison.

Pine, Tillie S., and Levine, Joseph. The Chinese Knew. Illustrated by Ezra J. Keats. McGraw, 1958, 32 p., $3.25. Grades K-4.

The ancient Chinese employed the same scientific principles we use today in making ink and paper, in making and using the abacus and water clock, and in other activities. This book includes directions for making some of the objects as well as experiments for proving the principals involved.

Podendorf, Illa. The True Book of Space. Illustrated by Robert Borja. Grosset, 1959, 48 p., $2.00. Grades 1-4.

What is a satellite? Where is space? How do rockets travel in outer space? When can we travel in outer space? Many mathematical concepts are used in discussing such questions.

Reed, Mary, and Osswald, Edith. The Golden Picture Book of Numbers: What They Do. Illustrated by Corinne Malvern. Simon, 1954, 80 p., $1.50. Grades 1-3.

Numbers are used in stories to describe size of groups, time, money, and comparative size of objects.

Rothschild, Alice. Bad Trouble in Miss Alcorn's Class. Illustrated by Irwin Rosenhouse. Scott, 1959, 101 p., $2.75. Grades 1-3.

A wise teacher and children solve the problem of stealing in a second grade. The vocabulary of number, position, relationship, and time are used.

Russell, Betty. Big Store, Funny Door. Illustrated by Mary Gehr. Whitman, 1955, unpaged, $1.25. Grades K-3.

Two children travel through a supermarket, using ideas of number, operation and measurement.

Schlein, Miriam. City Boy, Country Boy. Illustrated by Katherine Evans. Grosset, 1955, unpaged, $2.80. Grades 2-3.

A boy who lives in the country and one who lives in the city each describes his life during one year, using concepts of time, size, position, and numbers.

Schlein, Miriam. Fast Is Not A Ladybug. Illustrated by Leonard Kessler. Scott, 1953, unpaged, $2.25. Grades K-3.

This narrative about moving objects helps to make meaningful the concepts of fast and slow.

Schlein, Miriam. Heavy Is A Hippopotamus. Illustrated by Leonard Kessler. Scott, 1954, unpaged, $2.50. Grades K-3.

Excellent text and illustrations are given for helping children understand the relative nature of light and heavy. What is heavy for an ant is light to a child; what is heavy to a child is light to a hippopotamus.

Schlein, Miriam. It's About Time. Illustrated by Leonard Kessler. Scott, 1955, unpaged, $2.00. Grades 1-3.

Verse and pictures develop the concept of time. Various units of time, such as second, minute, hour, and day, are introduced.

Schlein, Miriam. Shapes. Illustrated by Sam Berman. Scott, 1952, unpaged, $2.50. Grades K-2.

Familiar objects help develop the concept of shapes. Descriptive vocabulary includes round, square, line, straight line, curve, long, and tall.

Shapp, Charles, and Shapp, Martha. Let's Find Out What's Big and What's Small. Illustrated by Vana Earle. Watts, 1959, unpaged, $1.95. Grades 1-3.

Text and pictures show vividly the relative meaning of size. These questions are discussed: What is big? What is small? What is short? What is tall?

Sharp, Elizabeth N. Simple Machines and How They Work. Illustrated by Ida Scheib. Random, 1959, 96 p., $1.95. Grades 1-3.

This account of wheels, pulleys, levers, screws, wedges and inclined planes, with experiments to prove their usefulness, makes extensive use of the language of size, position, and comparison.

Skaar, Grace. The Very Little Dog. Scott, 1949, 19 p., $1.50. Grade K.

In text and pictures a little dog grows bigger and bigger. Elementary comparative language is used.

Slobodkin, Louis. Millions and Millions. Vanguard, 1955, unpaged, $2.95. Grades K-1.

Pictures and text combine to develop effectively the idea of millions as many.

Slobodkin, Louis. One Is Good But Two Are Better. Vanguard, 1956, unpaged, $2.95. Grade K.

Ideas of one and two are developed through examples of activities in which two can play better than one.

Tresselt, Alvin. Follow the Road. Illustrated by Roger Duvoisin. Lothrop, 1953, unpaged, $2.75. Grades 1-2.

Ideas of space, time, quantity, and size are used to tell about a small boy who decides to take his wagon and follow the road.

True, Louise, and Owens, Lillian. Number Men. Grosset, 1948, 32 p., $2.30. Grades 1-2.

Directions for writing the number symbols from one to ten are given in verse. The pictures of groups of objects are simple and easy to use.

Tudor, Tasha. Around the Year. Walck, 1957, 56 p., $3.00. Grades K-3.

Effective pictures and verse tell about each month of the year.

Tudor, Tasha. 1 Is One. Walck, 1956, unpaged, $2.75. Graded K-1.

This counting book effectively illustrates each number group from one through twenty.

Watson, Nancy Dingman. Annie's Spending Spree. Illustrated by Aldren A. Watson. Viking, 1957, 45 p., $2.50. Grades K-3.

Annie learns about her birthday dollar in terms of half-dollars, quarters, dimes, nickels, and cents. Her adventure at a store helps her appreciate its value as she finds what she can buy.

Watson, Nancy Dingman. What Is One? Illustrated by Aldren A. Watson. Knopf, 1954, unpaged, $2.25. Grades K-1.

A boy uses easy and commonplace examples to teach his younger sister the meaning of the numbers from one to ten.

Watson, Nancy Dingman. When is Tomorrow? Illustrated by Aldren A. Watson. Knopf, 1955, unpaged, $2.75. Grades K-1.

Linda's confusion with tomorrow and today provides an opportunity for children to develop a better understanding of the concept of time.

Webber, Irma E. It Looks Like This. Scott, 1958, unpaged, $2.00. Grades 1-3.

Four mice look at animals from different views; front, back, side, and above. Each animal presents different pictures, depending on the position of the viewer. The mice conclude that one object can have as many different appearances as there are ways to look at it.

Wondriska, William. 1, 2, 3, A Book To See. Pantheon, 1959, unpaged, $2.50. Grades K-1.

Number symbols from 1 through 10 are illustrated by large, clear figures, offering material for development of group recognition and counting.

Woolley, Catherine. Two Hundred Pennies. Morrow, 1947, 128 p., $2.75. Grades 1-3.

A boy wants to buy a track for an electric train. The value of a dollar in pennies is developed and addition and subtraction ideas are introduced.

Ziner, Fennie, and Thompson, Elizabeth. The True Book of Time. Grosset, 1956, unpaged, $2.00. Grades 1-3.

Different ways people have recorded the passing of time are explained in simple terms and an easy lesson is given on the modern clock.

Zolotow, Charlotte. One Step, Two . . . Illustrated by Roger Duvoisin. Lothrop, 1955, unpaged $2.50. Grade K.

Ellen and her mother take a walk and use the vocabulary of number, comparison, position, size, shape, and time as they describe what they see. The illustrations are effective.

Zolotow, Charlotte. Over and Over. Illustrated by Garth Williams. Harper, 1957, unpaged, $2.75. Grade K.

Holiday after holiday comes for a little girl, and she wishes for them all to come again. This is excellent for developing the idea of time.

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